United States Patent [19]

Johnson et al.

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[45] **Date of Patent: Nov. 11, 1986**

[54] **ELECTRIC PUMP**

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[73] Assignee: **Liquid Level Lectronics, Inc.**, Porter, Tex.

[21] Appl. No.: **789,155**

[22] Filed: **Oct. 18, 1985**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 777,709, Sep. 11, 1985.

[51] **Int. Cl.**[4] **F04B 39/14**; F04B 49/00

[52] **U.S. Cl.** **92/13.4**; 92/128; 417/454

[58] **Field of Search** 92/60.5, 13.4, 128, 92/13.41, 13.8; 417/274, 499, 454

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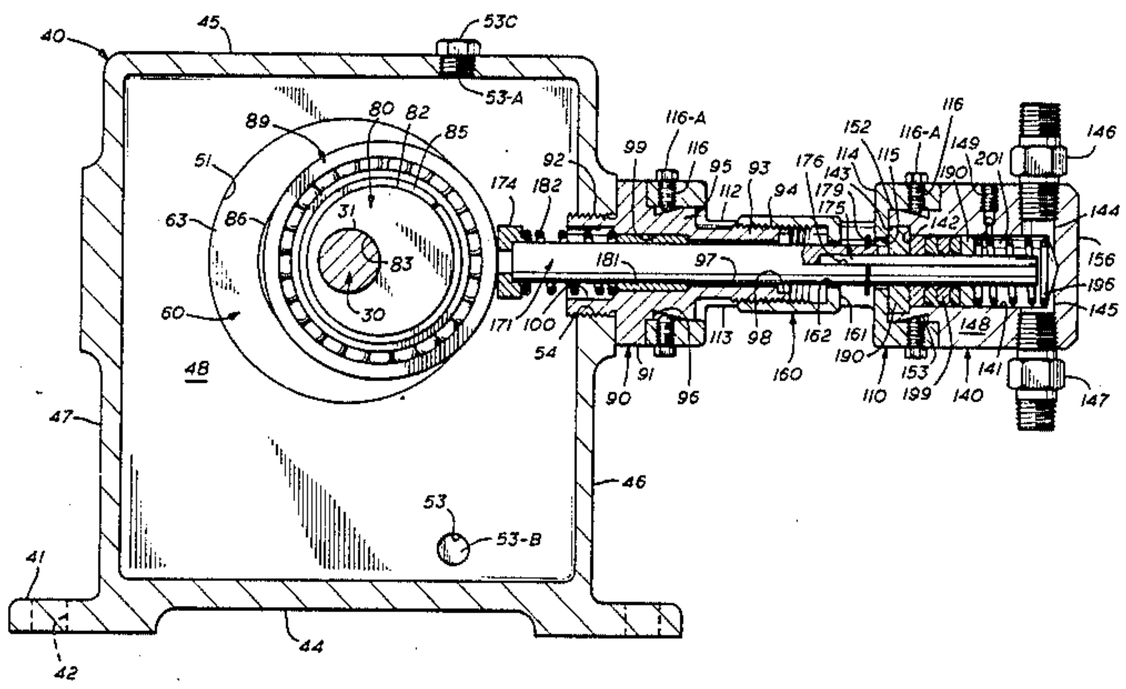
Primary Examiner—William L. Freeh
Attorney, Agent, or Firm—Robert W. B. Dickerson

[57] **ABSTRACT**

An electrically operated injection pump having an eccentrically mounted cam for reciprocating a spring-biased plunger, said plunger causing the receiving of injection fluid during intake stroke, and the ejection of such fluid during the exhaust stroke.

2 Claims, 24 Drawing Figures



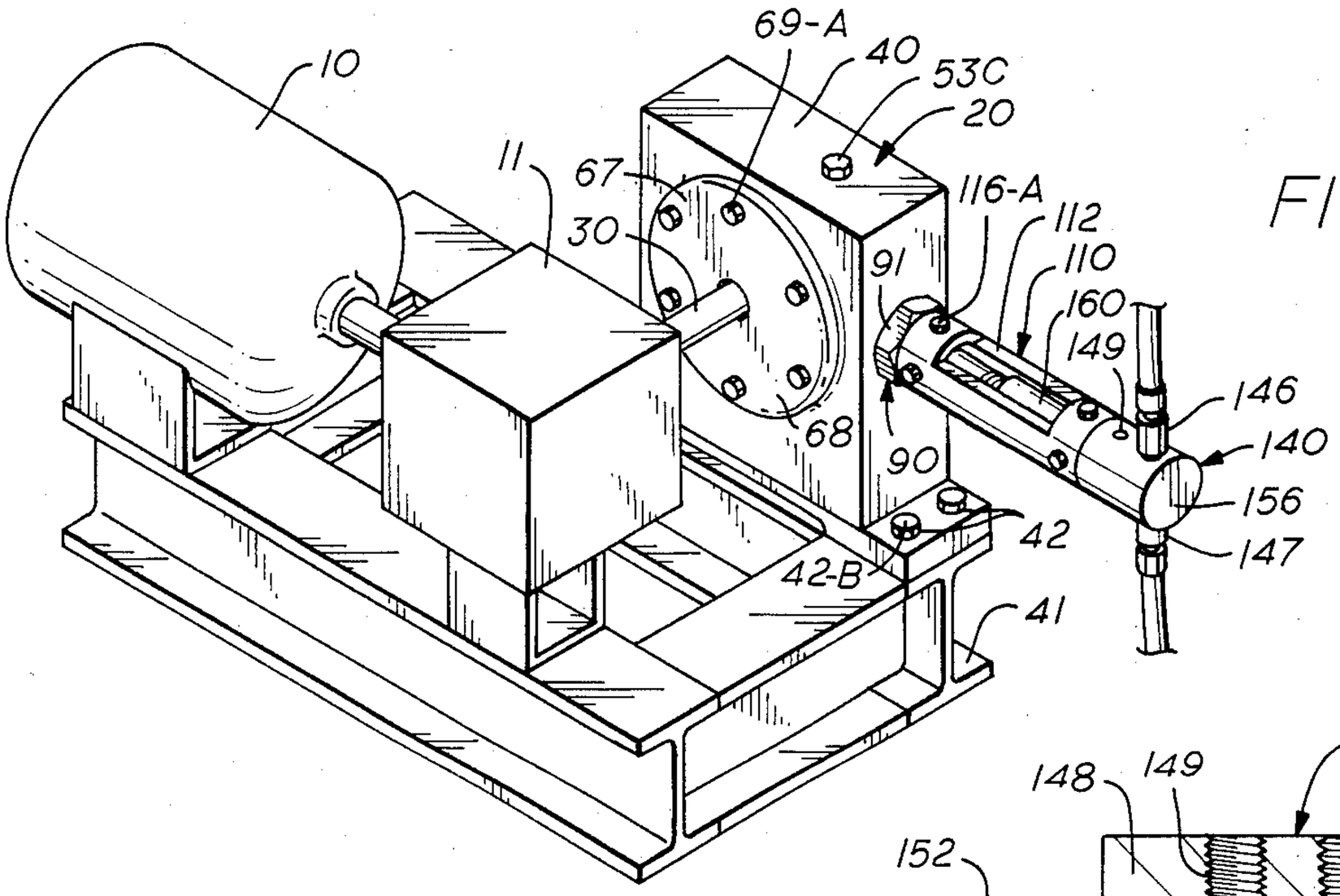
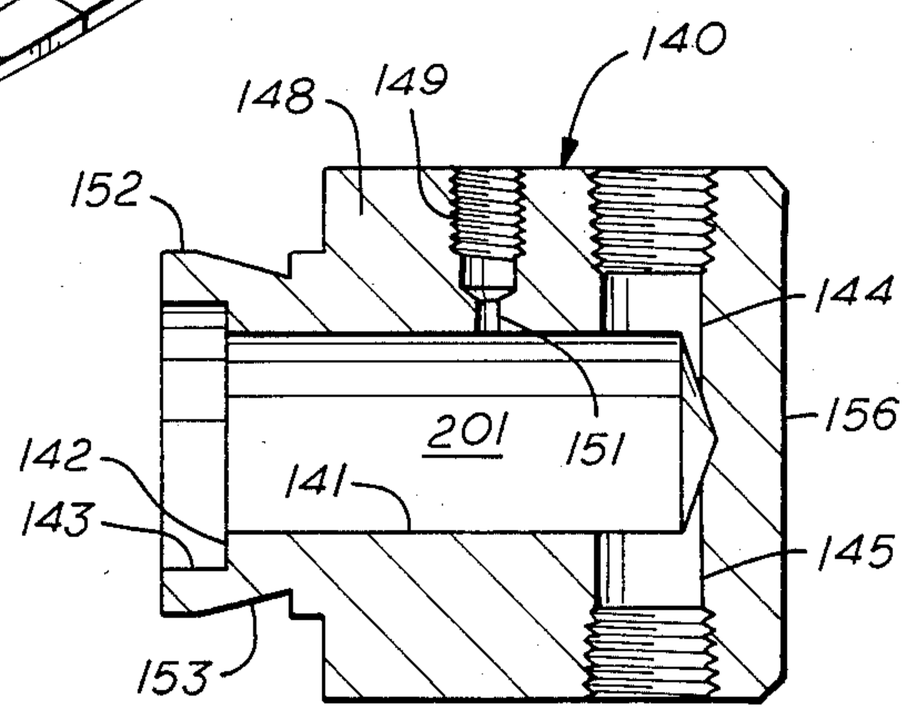


FIG. 1



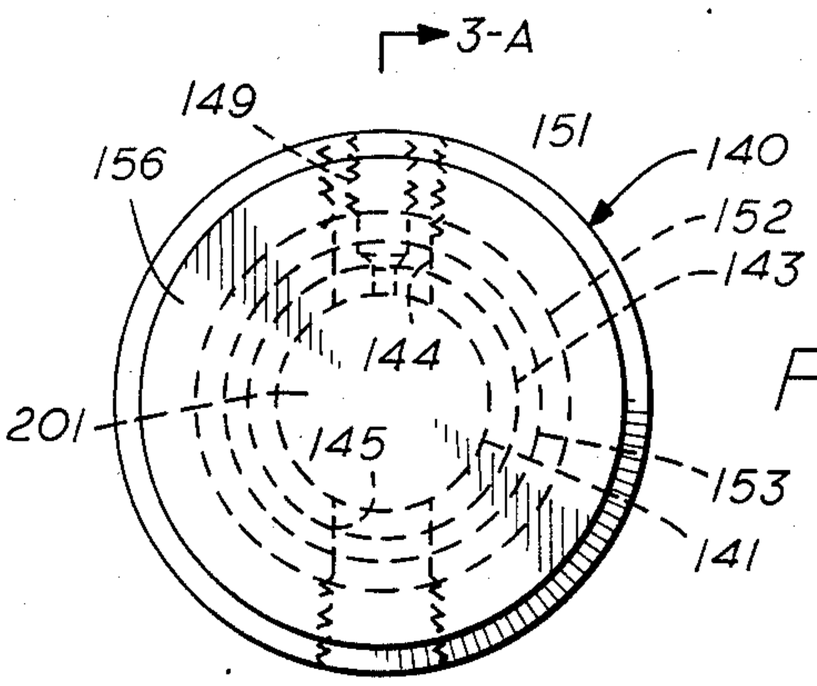


FIG. 3

FIG. 3-A

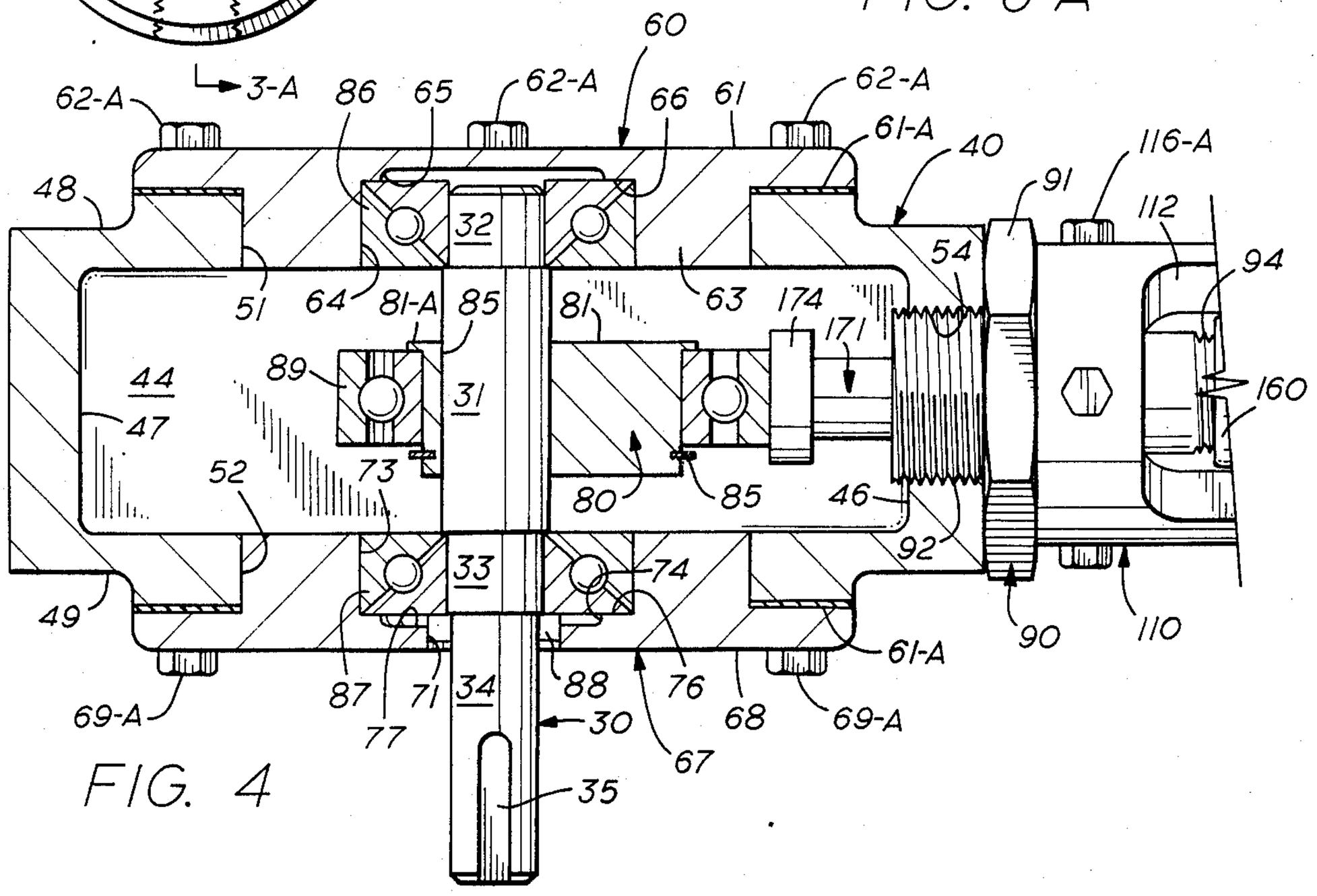
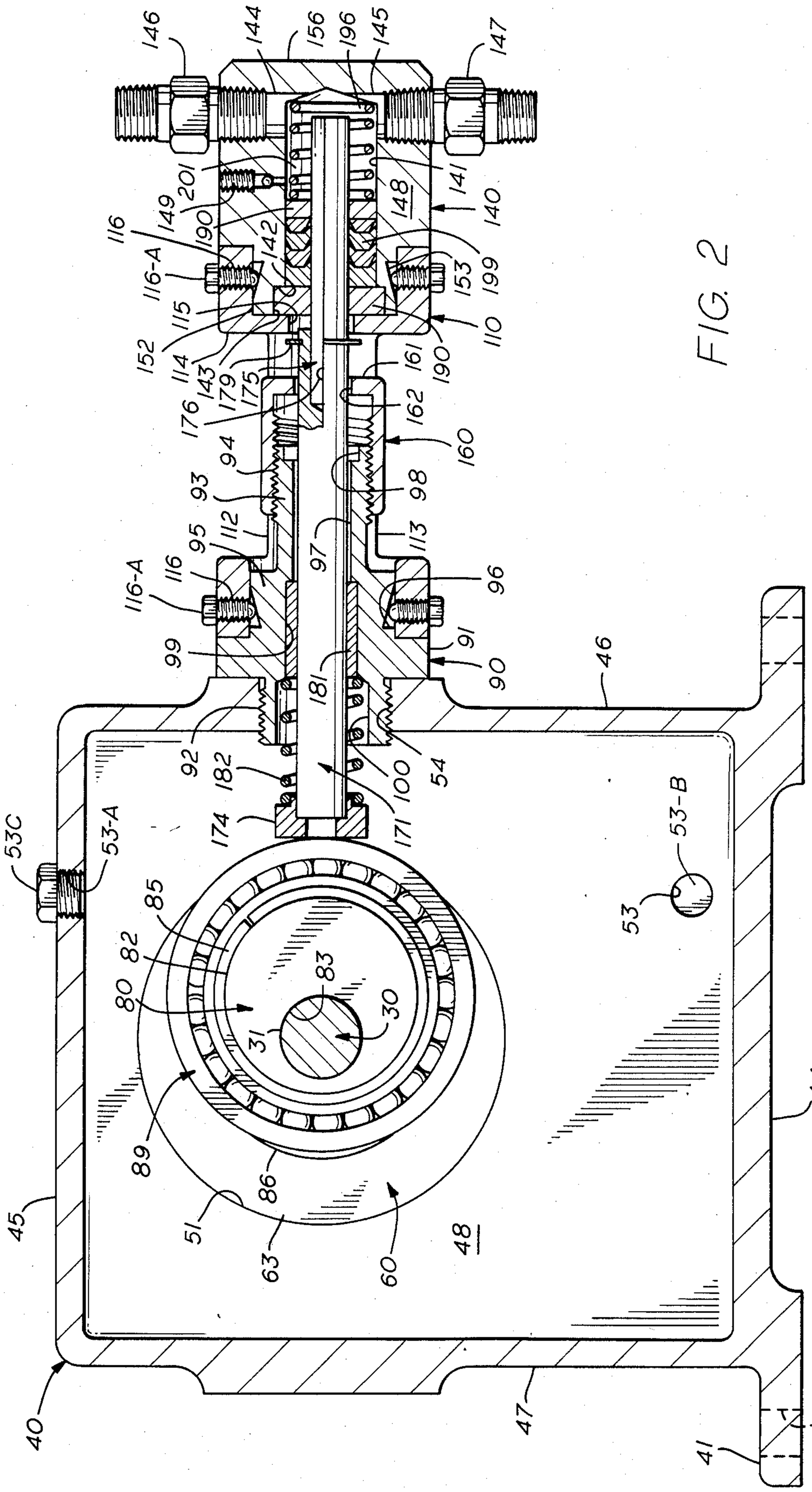


FIG. 4


146
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116-A
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110
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93
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116-A
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99
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90
181
46
92
182
174
100
171
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53C
53-A
53-B
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FIG. 2

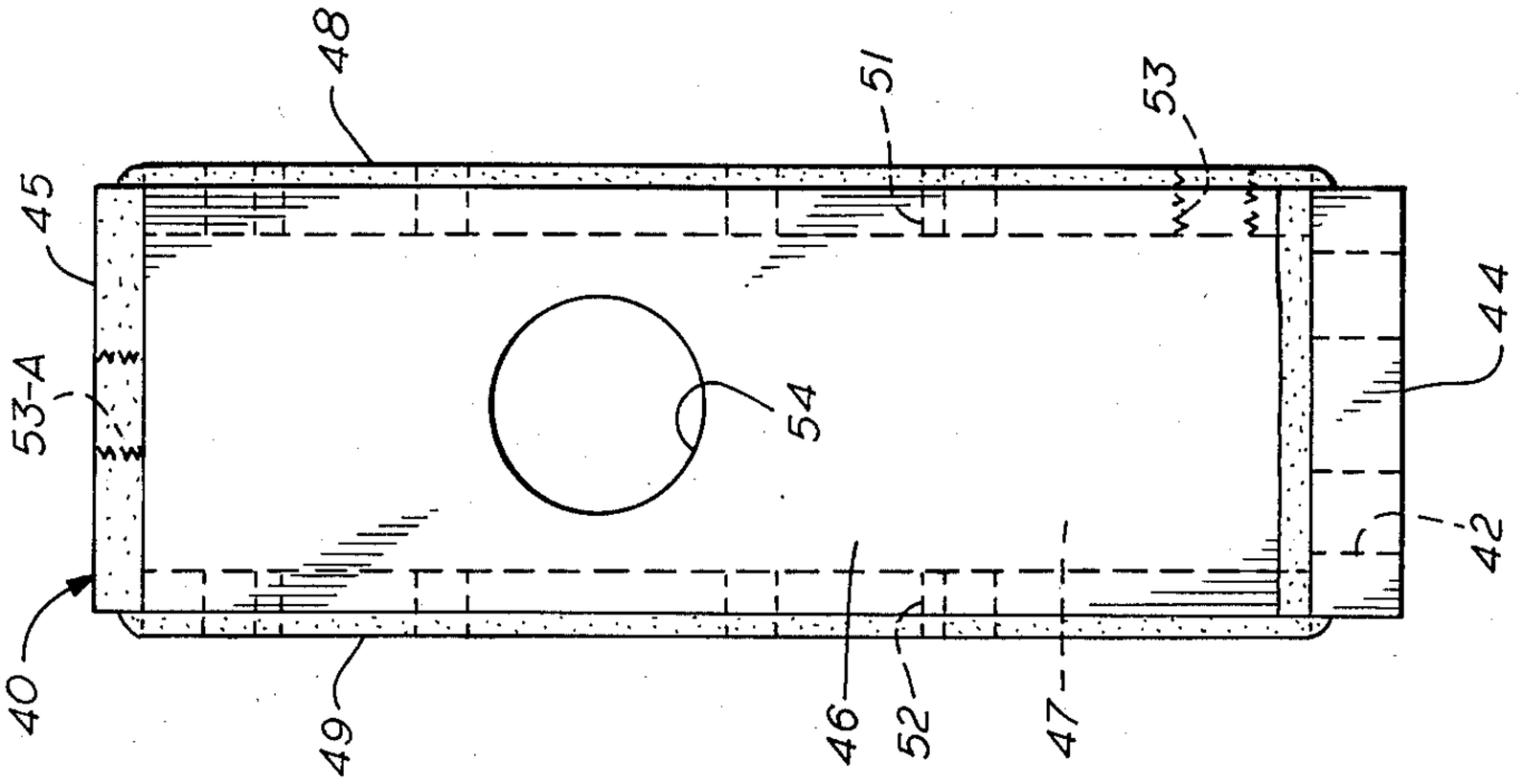
48
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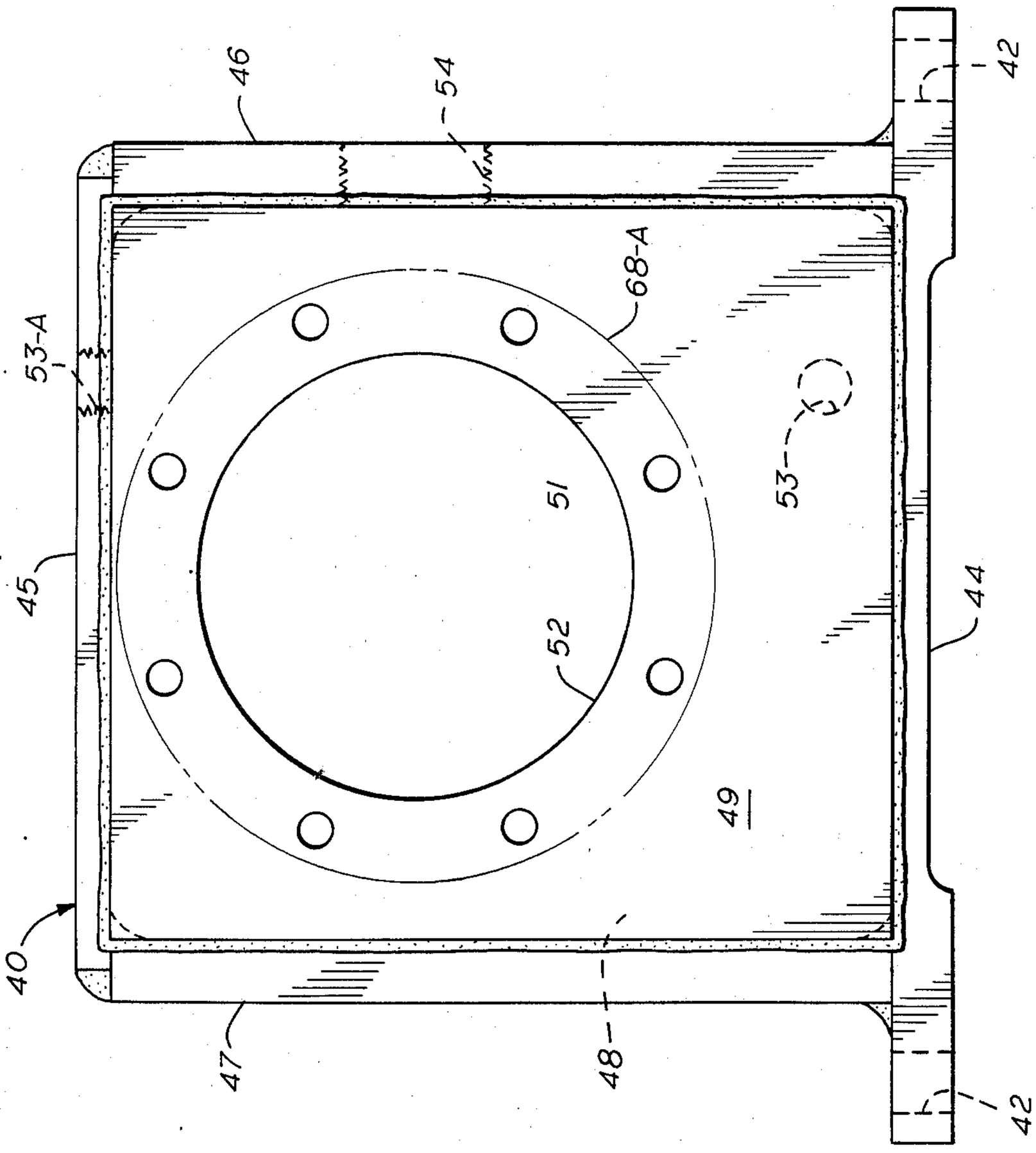
FIG. 6


46
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53-A
68-A
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FIG. 5

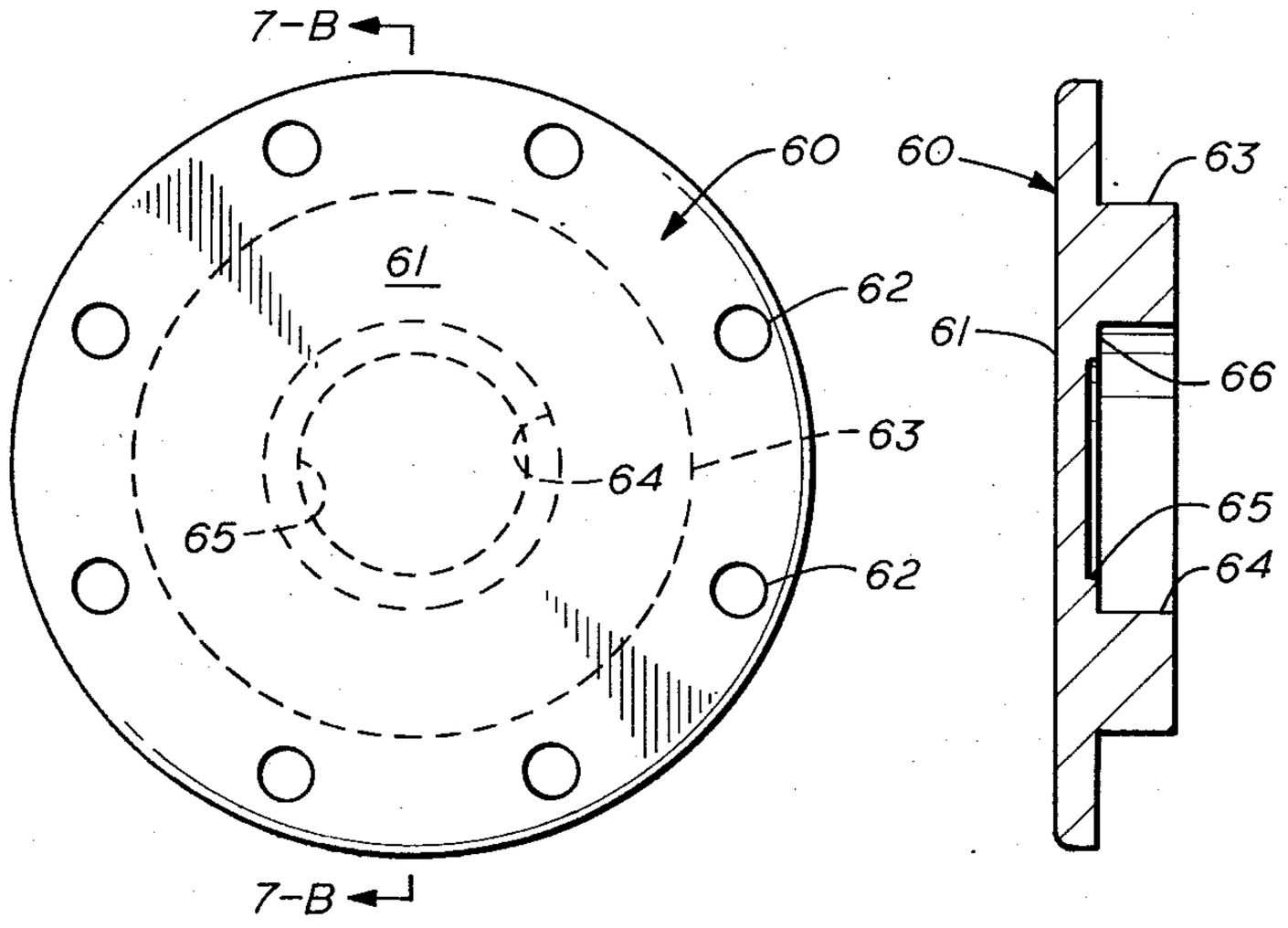

FIG 7-A

FIG. 7-B

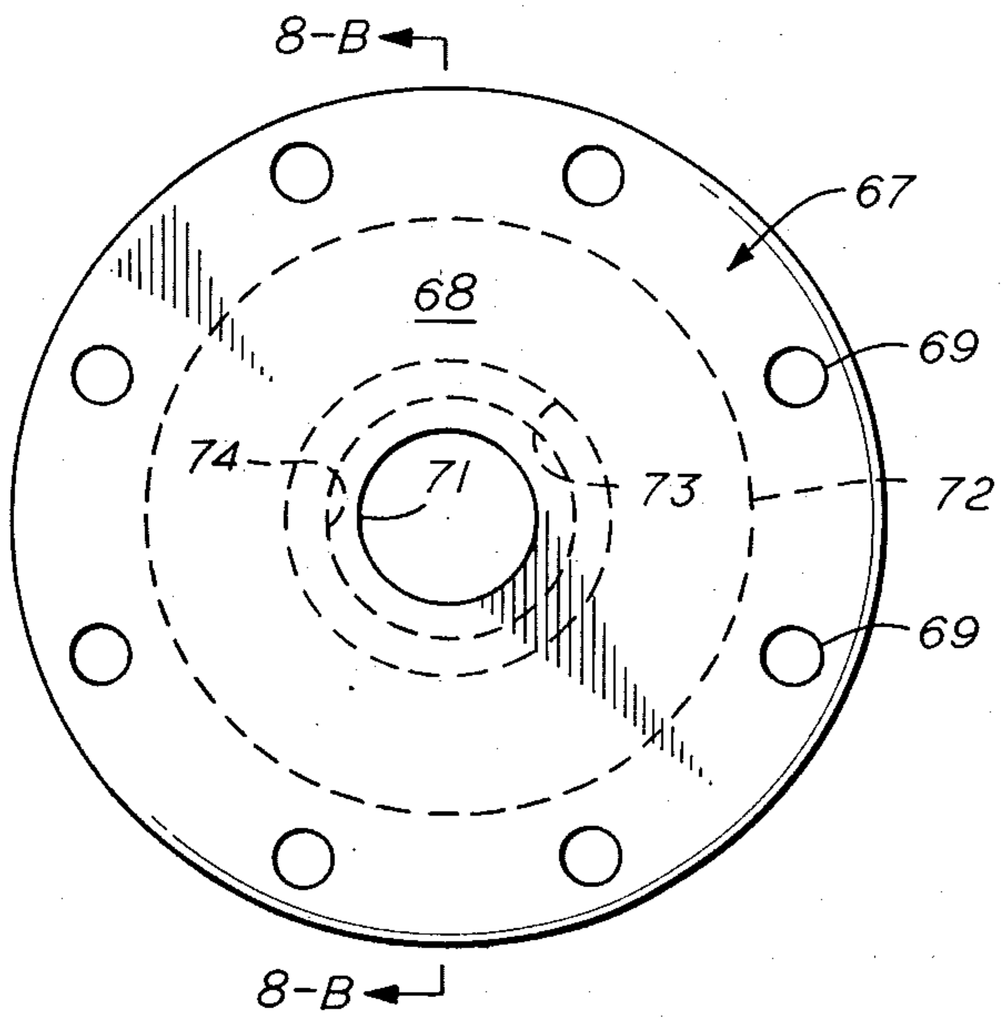

FIG. 8-A

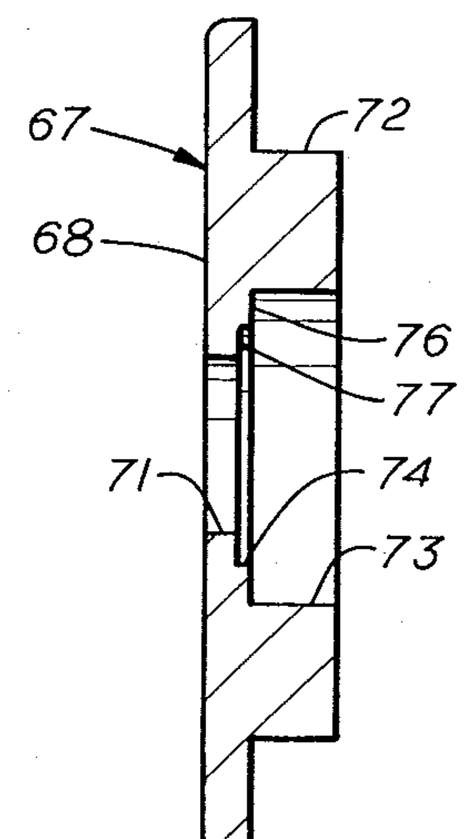

FIG. 8-B

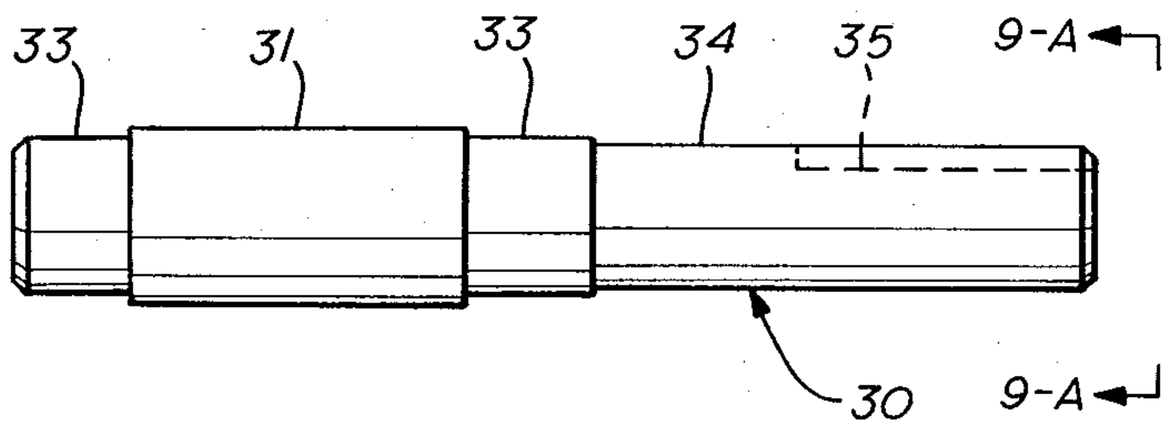

FIG. 9

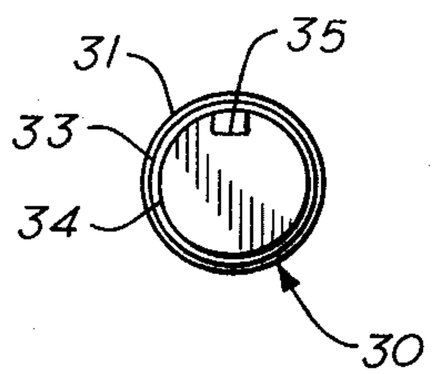

FIG. 9-A

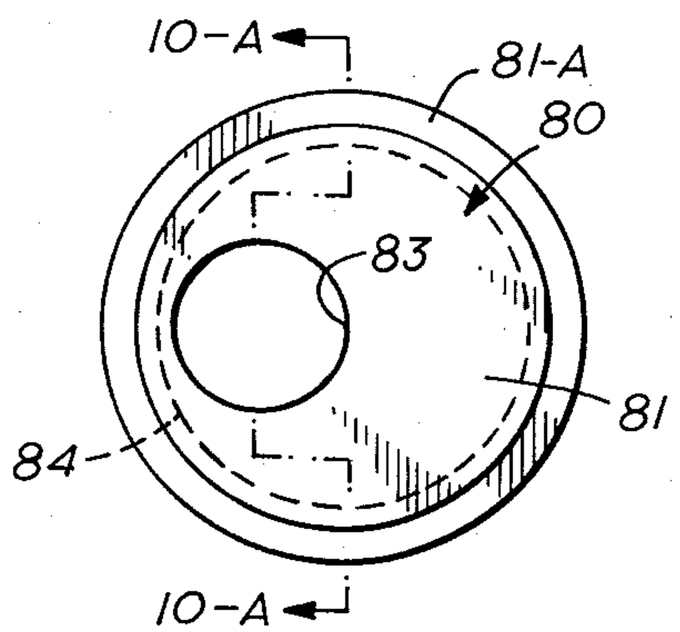

FIG. 10

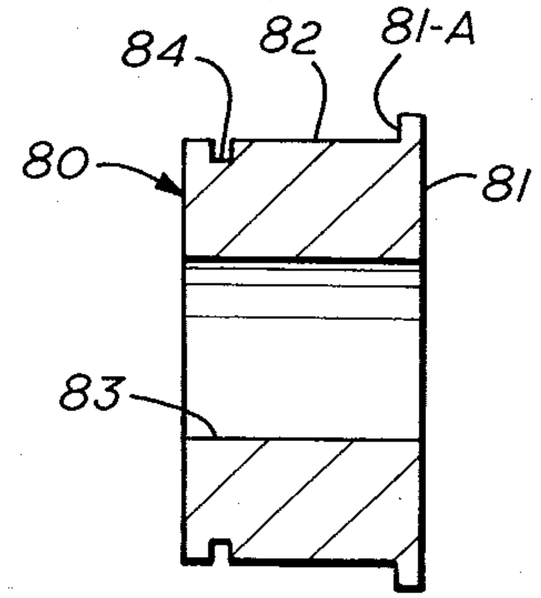

FIG 10-A

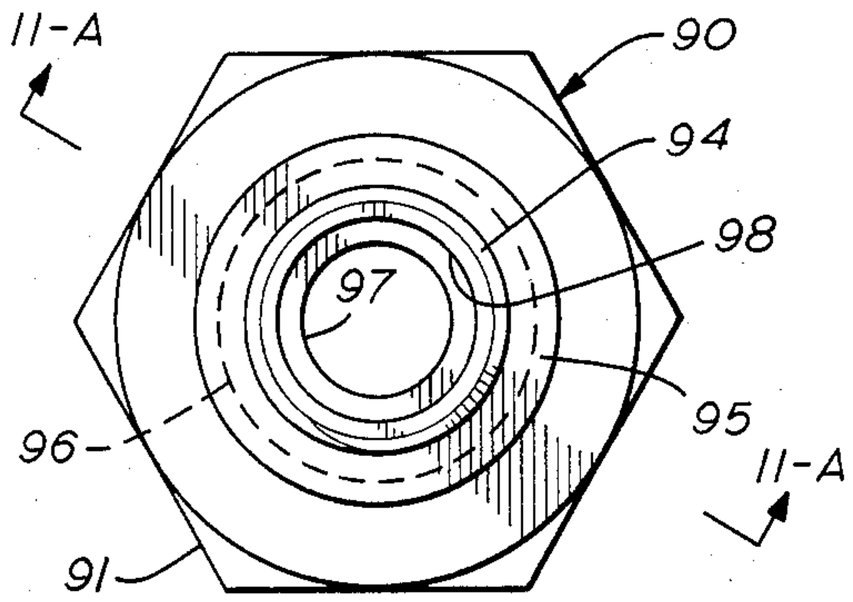

FIG. 11

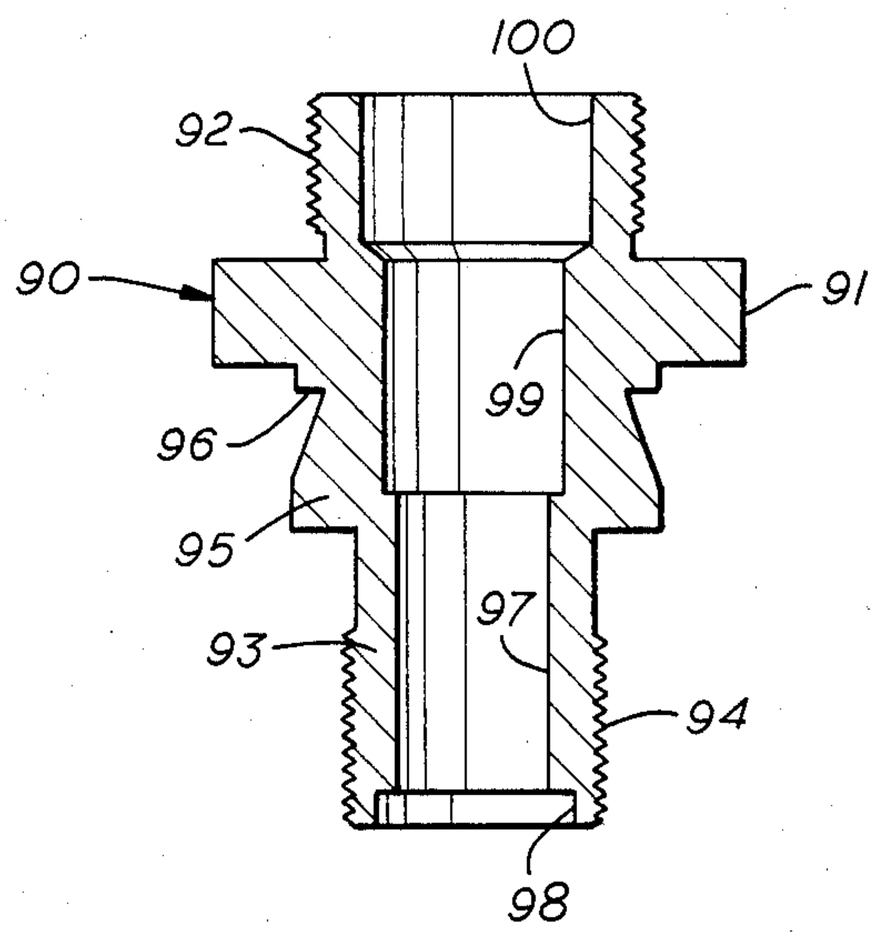

FIG. 11-A

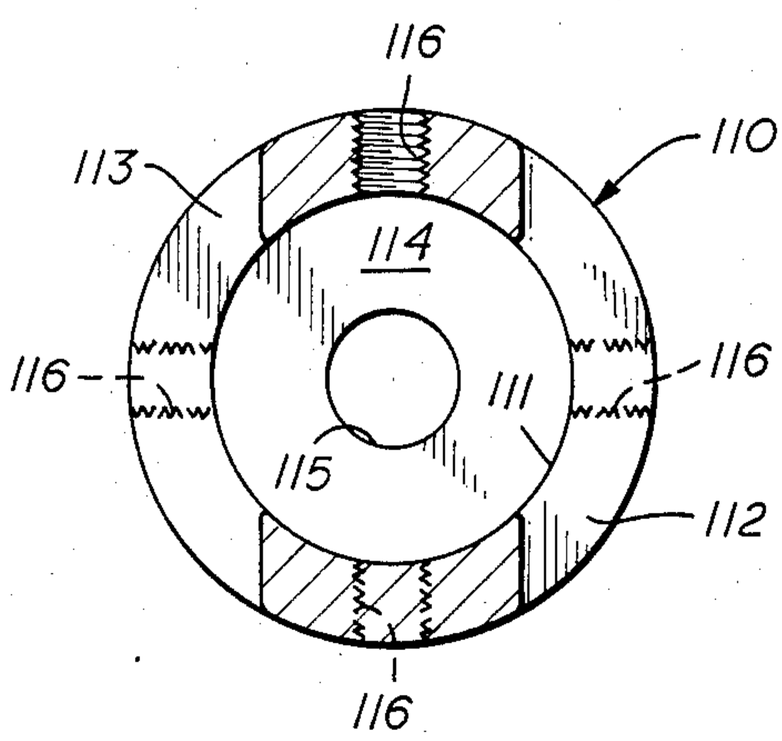

FIG. 12-A

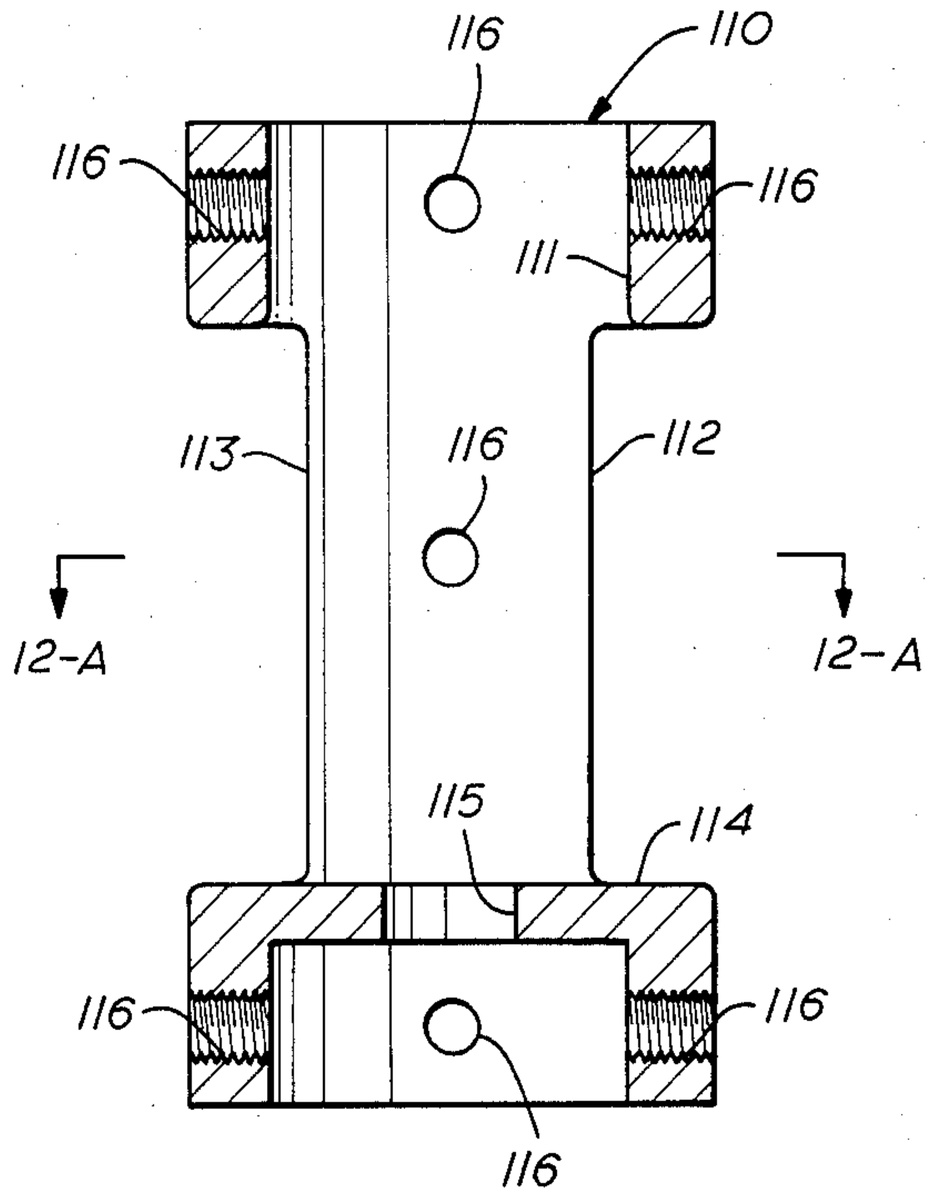

FIG. 12

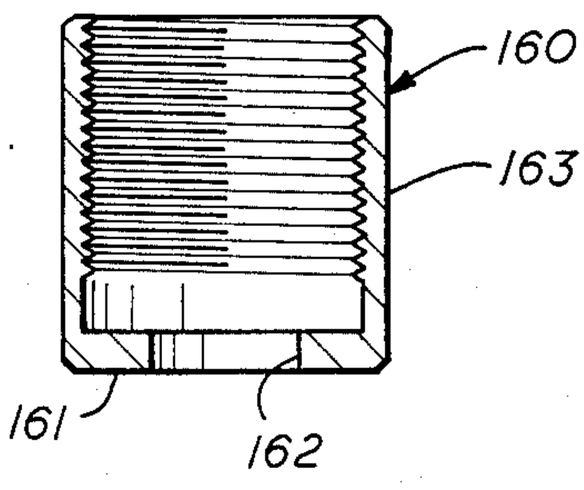

FIG. 13

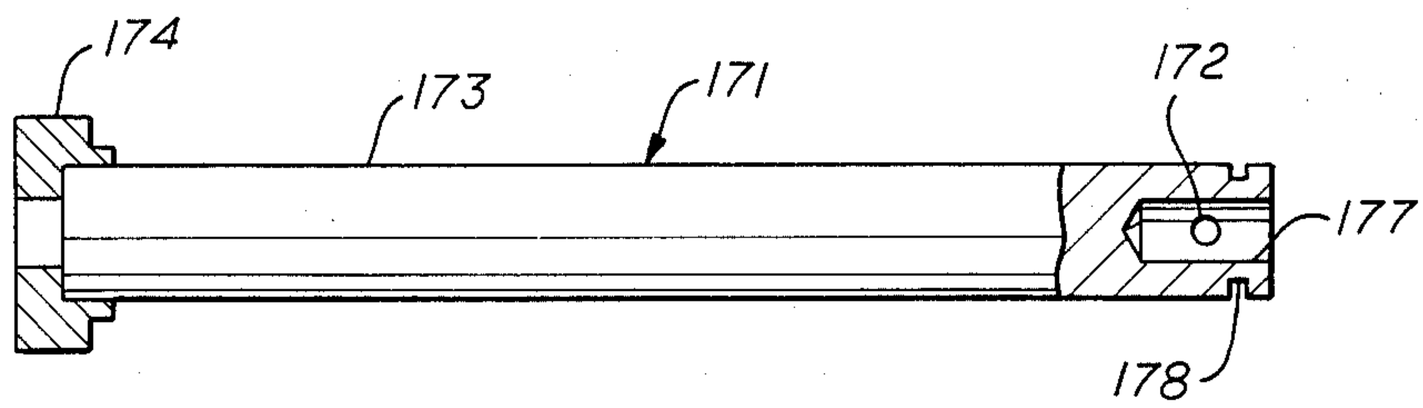

FIG. 14

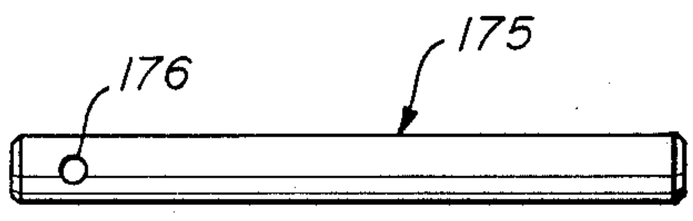

FIG. 15

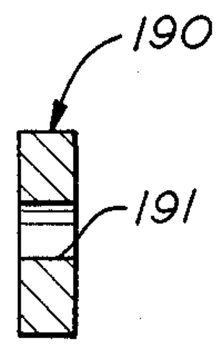

FIG. 16

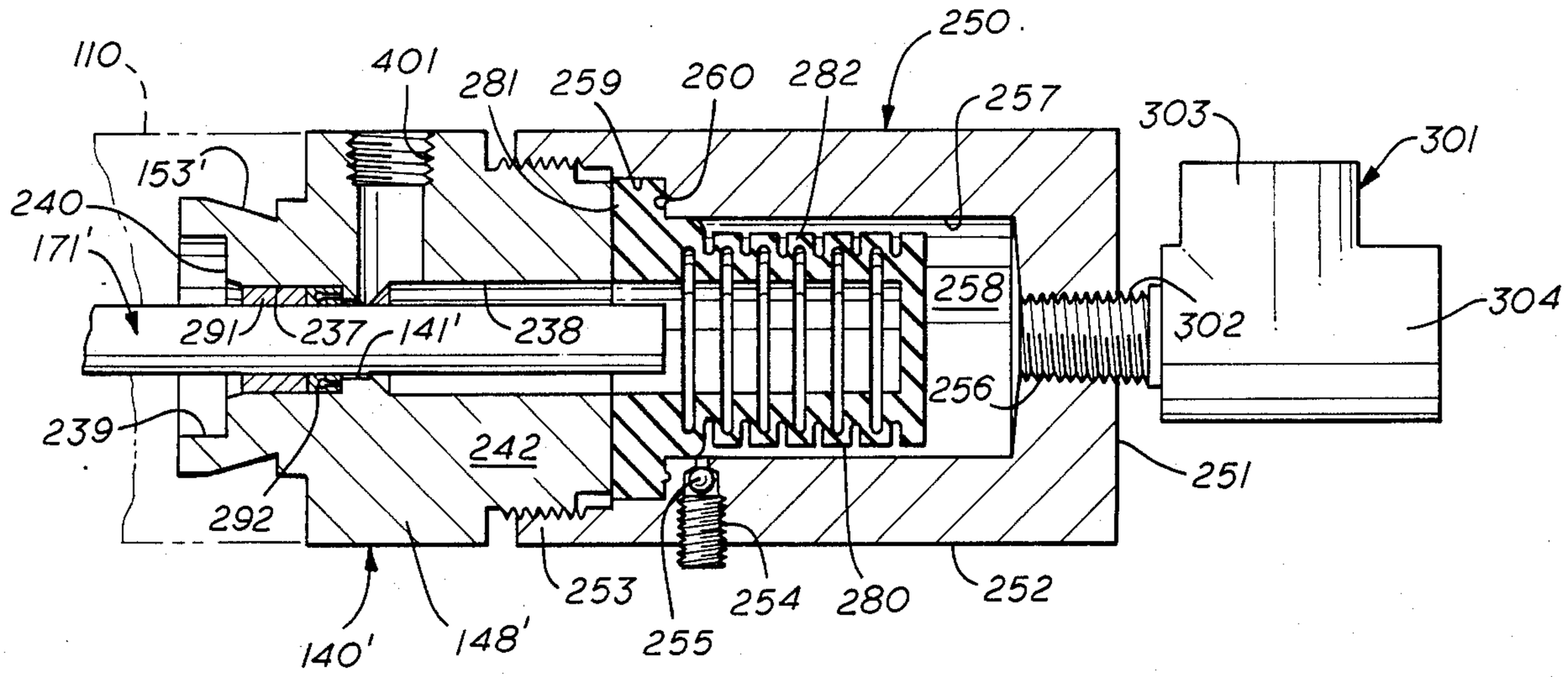

FIG. 17

ELECTRIC PUMP

This application is continuation in part of prior co-pending application Ser. No. 777,709 entitled "PUMP" filed on Sept. 11, 1985.

BACKGROUND OF THE INVENTION

The injection of chemicals in order to enhance the production of hydrocarbon products from a well, has long been practiced. Many types of pumps have been used. It is desirable to provide a discreet amount of chemical, withdrawn from a source, at regular intervals, to a production well. Obviously other operations than production wells may have such needs. Various problems have occurred. Applicants' prior copending application dealt with the prevention of contamination of or by the injection fluid, by using 2-way seals around a reciprocating plunger. A particular problem addressed by this invention, is the excessive amount of energy necessary to cause pump plunger reciprocation, and the excessive wear, and thereby cost of operation. Applicants have attempted to solve this problem by providing a low friction mechanism for reciprocating said plunger.

SUMMARY OF THE INVENTION

An electric motor, through a gear box, rotates a pump input shaft. Said shaft carries an eccentrically mounted cam. The cam, in turn, carries a ball bearing assembly around its periphery. Injection fluid is withdrawn from a source into a valve reservoir by the suction action caused by the intake stroke of a reciprocating plunger. Likewise, such fluid is ejected from the reservoir toward the end use, such as a production well, by the exhaust stroke of such plunger. Such reciprocation is caused by said rotating cam's bearing assembly pressing against an end of said plunger. Such intimate relationship is assured by said plunger being spring urged in the direction of the cam.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective of the pump, as related to an electric motor and gear box;

FIG. **2** is a rear elevation of pumphousing and pumphead, with the housing's rear cover plate removed, and the head shown in vertical section;

FIG. **3** is an end elevation of the housing and pumphead end fitting and FIG. **3**-A is a section taken along lines **3**-A—**3**-A of FIG. **3**;

FIG. **4** is a broken top elevation of the housing, with cover plate removed;

FIGS. **5** and **6**, respectively are rear and end elevations of the pumphousing;

FIGS. **7**-A, **7**-B are respectively a front elevation and a vertical axial section of a front bearing mounting plate;

FIGS. **8**-A, **8**-B are respectively a front elevation and vertical axial section of a rear bearing mounting plate;

FIG. **9** is a side elevation of the pump input shaft;

FIG. **9**-A is an end elevation of the shaft of FIG. **9**;

FIG. **10** is a rear elevation of the cam;

FIG. **10**-A is a section taken along line **10**-A—**10**-A of FIG. **10**;

FIG. **11** is an end view of the headmounting adapter, while FIG. **11**-A is a sectional view thereof taken along lines **11**-A—**11**-A of FIG. **11**;

FIG. **12** is a vertical axial section of FIG. **12**-A while FIG. **12**-A is a sectional view taken along lines **12**-A—**12**-A of FIG. **12**;

FIG. **13** is an axial section through the collet;

FIG. **14** is a partly broken away, elevation of the plunger base;

FIG. **15** is a front elevation of the plunger stem;

FIG. **16** is an axial section through the back-up washer; and

FIG. **17** is a vertical axial section of the connector, used to permit bellows operation, as connected with the bellows housing.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **1** generally indicates an electric motor **10** which, through intermediate gear box **11**, rotates input shaft **30** (later described) of pump **20**. The linkage between gear box **11** and pump input shaft **30** may be a shaft to collar to shaft, for example, but is not specifically illustrated, in that per se use of an electric motor to rotate a shaft through an intermediate gear box, is not new. Pumphousing **40** is secured to flanges **41**, which may be anchored to a skid by bolts **42**-B passing through apertures **42**.

Pumphousing **40** includes bottom and cover plates **44**,**45**, as well as end plates **46**,**47** and front and rear plates **48**,**49**. Said front and rear plates are approximately centrally apertured at **51**,**52** respectively, so as to receive front and rear bearing mounting plates **60**,**67**. Said front cover plate **48** is also apertured at **53**, forming an oil drain which may be closed by a plug, **53**-B. End plate **46** is threadedly apertured at **54** to receive the pumphead, later described. Cover plate **45** is threadedly apertured at **53**-A, forming an oil fill, which may be closed by a plug, **53**-C. The housing interior may be filled with oil.

Cylindrical mounting plate **60** includes an annular front face **61** with a plurality of bolt receiving, apertures **62** around its periphery for securing said plate, by bolts **62**-A, to housing front plate or wall **48**. Gasket material **61**-A may be provided therebetween. Skirt **63** depends from member **61** and includes bore **64**, and dead-end counterbore **65** communicating therewith by virtue of shoulder **66**.

Rear mounting plate **67** includes an annular front face **68** with a plurality of bolt receiving apertures **69** around its periphery for securing said plate, by bolts **69**-A, to housing rear plate or wall **49**. Front face **68** of mounting plate **67** is centrally apertured at **71**. Skirt **72** depends from member **68** and includes bore **73** and counterbore **74**. Said counterbore **74** communicates with bore **73** by shoulder **76**, and with aperture **71** by shoulder **77**.

Pump input shaft **30** is cylindrical in configuration and includes enlarged body **31**, with chamfered nose **32** depending from one end thereof. Reduced diameter portion **33** depends from the other end of body **31**, and further reduced chamfered tail **34** depends from portion **33**. Tail **34** includes keyway **35**. A motor controlled output shaft (not shown) would be linked to shaft **30**, keyed to keyway **35**, through gear box **11**, in a conventional manner, thereby rotating shaft **30**.

Cam **80** includes annular face **81** having depending cylindrical skirt **82**. Axially eccentric bore **83** extends through said face and skirt. Annular cut-out **84** receives locking ring **85**. Cam **80** is eccentrically mounted (as by welding) on shaft **30**. Annular ball bearing assemblies **86**,**87** conventionally having inner and outer races rotat-

ably receive shaft nose **32** and shaft reduced portion **33**, annular seal **88** preventing leakage from the interior of pumphousing **40**. Cam **80** carries ball bearing assembly **89** around its periphery, secured thereto by lip **81**-A of face **81** and locking ring **85**.

Consider now the pumphead and its components. Mounting adapter **90**, especially see FIGS. **11** and **11**-A, includes an integral hex-head nut **91** forming the central portion. An exteriorly threaded nose **92** depends from said nut portion and engages the interiorly threaded aperture **54** of pumphousing end plate **46**. Tail portion **93** is exteriorly threaded at **94**, said tail portion being linked to nut **91** by cylindrical connector portion **95**. The said connector portion is annularly cut away at **96**. Extending axially through mounting adapter **90**, are a series of communicating bores and counterbores, namely bore **97**, seal-receiving counterbore **98**, bushing receiving counterbore **99** and spring seat counterbore **100**. Said seal and bushing are illustrated in FIG. **2**.

Outboard of nut portion **91**, is hollow cylindrical head spacer **110**. This member includes an axial bore **111**. The axial bore is restricted by web **114** which has further axial bore **115** therethrough. The spacer also includes elongated apertures **112,113** through the spacer's cylindrical walls. Annularly spaced about the ends and middle of spacer **110** are a plurality of threaded taps **116**, for receiving set screws **116**-A to secure the spacer to the mounting adapter **90** and to the pumphead end fitting **140**, described hereinafter.

Further outboard from pump housing **40** is said pumphead end fitting **140** (see FIGS. **3** and **3**-A). This cylindrical member includes chamfered end wall **156**, dead-end axial bore **141** communicating at one end with counterbore **143** by virtue of shoulder **142**. Said dead-end creates reservoir **201** for injection fluid. Opposed, threaded, injection-fluid inlet and outlet **144,145** communicate with said bore **141**, at the dead end thereof. Threaded male fittings **146,147** having ball check valves therein for unidirectional fluid flow, communicate respectively with a supply of injection fluid and a well or other end use, in which such fluid is to be injected. Also communicating with bore **141**, through the wall of end fittings central housing **148** of end fitting **140**, is a threaded radial tap **149** and communicating bore **151** to receive a check valve mechanism, only generally shown in FIG. **2**, to relieve pressure build up within reservoir **201** of bore **141**. Nipple extension **152** depends from the end fitting's central housing **148**, said extension containing counterbore **143**. The outer annular wall of the nipple extension is annularly recessed at **153** to receive set screws passing through threaded taps **116**, thereby securing said end fitting to said spacer.**110**.

Collet or collar **160** (see FIG. **13**) includes web **161**, perforated at **162**, with internally threaded, depending skirt **163**. The outer skirt surface is knurled, for hand-gripping purposes. The inner skirt threads adjustably engage threads **94** of the adapter tail section. A user has access to this adjustment device, through apertures **112,113**. Rotating such collar **16** moves it axially along fixed adapter **90**, thereby controlling the stroke length of the plunger, hereafter described. FIG. **2** illustrates a very limited plunger stroke. By virtue of retainer ring **179**, secured to plunger portion **171**, the stroke length is limited to the axial distance between collet web **161** and the adjacent spacer web **114**.

The plunger (see FIGS. **14** and **15**), shown in FIG. **2**, is of two part construction and includes plunger base, or power plunger **171** which is roll pin connected to plunger stem **175** through their respective pin-receiving apertures **172, 176**. Stem **175** is simply a cylindrical rod, with chamfered ends. Power plunger **171** includes a cylindrical body **173**, having a head **174** secured to one end thereof, and a socket **177** internally formed in its other end. Power plunger aperture **172** actually passes through the wall of body **173**, surrounding said socket. The end of plunger stem **175**, adjacent aperture **176** would be urged within base socket **177**, have apertures **172,176** aligned, whereon they would be pin connected, for unitary action. For certain situations, having a requirement for a larger diameter plunger, a single, unitary plunger may be used. FIG. **2** indicates such alternative possibility by only partially depicting stem **175**. Similarly, the diameter of aperture **115** may vary. Finally, the diameter of aperture **191** through washers **190** may variably accommodate differently sized plungers as illustrated. Annular slot **178** extends around body **173**, to receive retainer ring **179**.

Bushing **181** would be positioned within counterbore **99**. Coil spring **182** is seated against both said fixed bushing and head **174**, thereby urging the plunger toward shaft **30**, ie., to the left in FIG. **2**.

Coil spring **196** would seat against the dead end of bore **141** as well as against the nearest of washers **190**. Chevron or "V" packing **199** encircles the plunger stem, and is kept compressed between washers **190** by the pressure of spring **196**.

In operation, electric motor **10**, through gear box **11**, would rotate input shaft **30**, in a conventional manner. Rotation of shaft **30** would cause rotation of eccentric cam **80**, secured to said shaft. Cam **80** carriers ball bearing assembly **89** annularly therearound. Power plunger head **174** is continuously urged toward said bearing assembly **89** by spring **182**. As shown in FIG. **2**, the plunger is urged to its optimum exhaust stroke by cam **80**, exhausting injection fluid from reservoir **201**, through outlet **147**, toward its objective. Conversely, when cam **80** is rotated 180 degrees, the plunger reaches it optimum suction stroke, drawing injection fluid from its source.

Numerous obvious benefits appear from the foregoing description. These include [1] modular construction of the pumphead, [2] friction reduction, with resultant decrease in both wear and tear and power loss, resulting from the ball bearing linkage between the cam and plunger, and [3] the ease of stroke adjustability by virtue of the knurled collar and access thereto.

In the event it is desirable to use the bellows arrangement of my copending application, entitled "PUMP" filed during September, 1985, the connector of FIG. **17** would be substituted for end fitting **140**, as follows. Connector **140'** (see FIG. **17**) would be positioned immediately outboard of adapter **110** in place of end fitting **140** which would be removed along with washers **190** and chevron packing **199**. This cylindrical member **140'** includes central housing **148'**, depending lip **241** and exteriorly threaded tail **242**, axial bore **141'** and opposed counterbores **237** and **238**, the former being in communication with further counterbore **239** by virtue of shoulder **240**. Annular recess **153'** receives the set screws passing through apertures **116**, to link the connector with spacer **110**. The said tail threads permit engagement with bellows housing **250**, as described in said prior copending application. Interiorly threaded reservoir fluid inlet **401** communicates with bore **141'** and counterbore **238**. A plug seal (not shown) may be

provided. Counterbore **237** receives bushing **291** and double acting seal **292**.

Bellows housing **250** is cup-shaped and includes web **251**, depending skirt **252**, interiorly threaded depending lip **253**, bleed port **254**, with ball check valve **255** provided therein, and injection fluid passageway **256**. An interior bore **257** and counterbore **259**, defines a reservoir for injection fluid **258** therein. Said bore **257** and counterbore **259** are joined by shoulder **260**. Bellows **280** includes axially hollow flange **281** and hollow skirt **282**. Said flange **281** is positioned intermediate bellows housing shoulder **260** and the adjacent end of connector **140'**.

T-configured exterior fitting **301** includes a threaded connection **302** engaging passageway **256**, as well as injection fluid inlet and outlet **303**, **304**, these latter members would include check valves to permit only unidirectional fluid flow.

This embodiment's operation, like that of the copending application; comprises plunger **171'** entering the hollow interior of bellows **280** during the exhaust stroke, and withdrawing therefrom during the suction stroke. Like said prior application, 2-way seal **292** prevents fluid leakage in either direction.

Although limited embodiments have been described, it should be obvious that numerous modifications would be possible by one skilled in the art without departing from the spirit of the invention, the scope of which is limited only by the following claims.

We claim:

1. An injection pump having an input shaft capable of being rotated by an outside source of power, said pump comprising:

housing member rotatably receiving said input shaft, said shaft having a cam eccentrically mounted thereon, said housing positioning ball bearing assembly means on opposite sides of said cam, for rotatably supporting said shaft, said cam carrying a further ball bearing assembly means around its periphery, said housing also including pumphead receiving means extending through a wall of said housing;

pumphead means in communication with said further ball bearing assembly means, said pumphead means including;

mounting means adapted to be received by said pumphead receiving means, said mounting means being axially bored and carrying means within said bore for (1) reciprocatingly receiving a plunger and (2) receiving spring means for biasing said plunger toward said cam,

spacer means removably secured to both said mounting means and to an injection fluid reservoir means, said spacer means being axially bored for receiving said plunger and further having aperture means for permitting access to an adjustment collar,

said adjustment collar including means which, in conjunction with said spacer means, adjusts the stroke of said plunger,

said injection fluid reservoir means being axially bored for receiving said plunger, said reservoir means including injection fluid inlet and outlet communicating with a reservoir portion, and

reciprocating plunger means in contact, at one end thereof, with said further ball bearing assembly means, its other end being reciprocatingly received by said reservoir portion of said reservoir means, said plunger further carrying means limiting said plungers stroke to the linear separation between one end of said adjustment collar and an adjacent web of said spacer.

2. The pump of claim **1** and including means for varying the effective diameter of said other plunger end.

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